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from the standpoint of some collateral branch of science. That the problem is a chemical one, there seems to be little doubt, but that it is also physiological is just as certain."

DESTROYING LICE ON TYPHUS FEVER SUSPECTS.

By S. B. GRUBBS, Surgeon, United States Public Health Service.

The importance of efficient and rapid methods of killing lice in clothing and on the human body is recognized by those charged with the exclusion of typhus fever from the United States. This disease, endemic in Mexico, requires energetic measures to prevent its spread northward, while the European War is so distributing it through southern Europe that renewed immigration may be expected to carry it across the Atlantic.

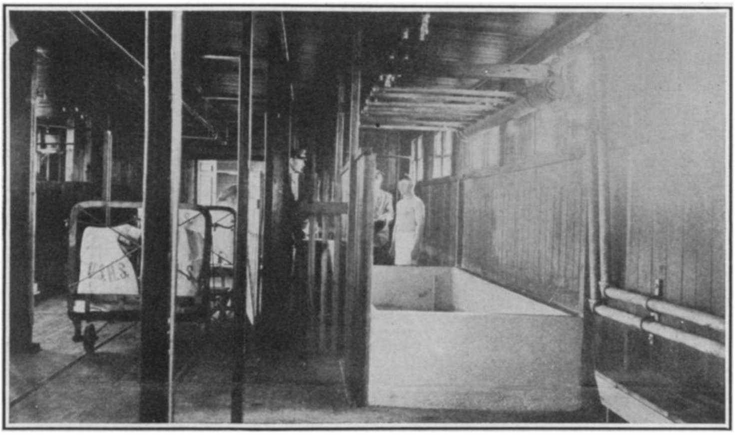
Studies that have been made during the past year at the Boston quarantine station, under the United States Public Health Service, have resulted in the adoption of a method of treating persons by means of a gasoline soap spray and shower bath and of treating clothing and baggage with a vacuum hydrocyanic acid gas process.

Equipment.—The bath house is an oblong building with a large steam chamber at one end, from which tracks extend the length of the building. A fence, with gate for the carriage from the steam chamber, has been built across the building, so that the only passage from one end of the building to the other is through a shower tank, 15 feet long. This tank is built of concrete, is 4 feet wide and holds 20 inches of water. At the entrance of the shower is a barrel with a spray pump with mechanical agitator. This pump, intended for spraying trees and plants, is especially adapted for emulsions, as it constantly agitates the solution. It operates by means of a pump handle and delivers with considerable force a fine or coarse spray as desired. Many soap combinations have been tried, all based on the kerosene emulsion spray used for plant lice and other insects. Gasoline has been substituted for kerosene, as reports from the English army in the trenches state that this was found to be a better remedy for lice. The formula adopted incorporates as much gasoline as possible without preventing the soap from lathering freely. For this the stock is made as follows:

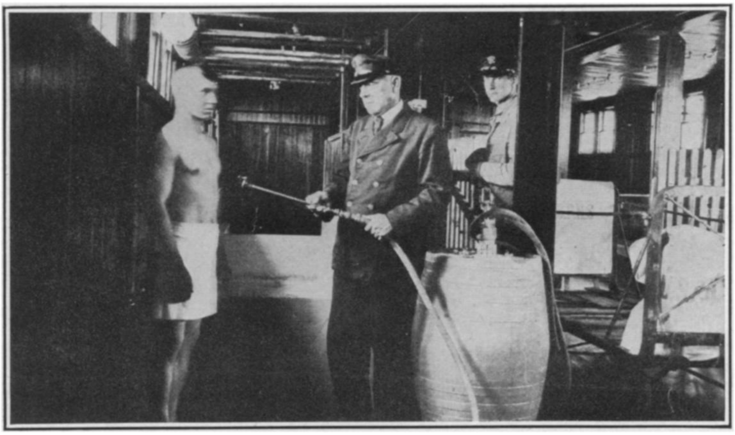
Soap chips or laundry soap	Part 1.
Soft water	Parts 4.
Gasoline	Parts 4.

Dissolve the soap by boiling in the water, remove from the fire and add the gasoline. Stir the mixture until it becomes a creamy mass of even texture without signs of either gasoline or soap. This hardens in a few hours to the consistency of stiff jelly.

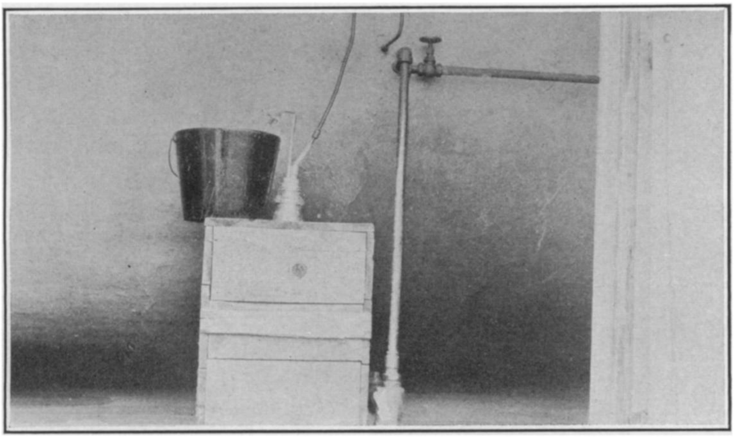
For spraying, this stock is mixed with five to ten parts of hot water and used while warm in order to lessen the chilling effects of the spray on the body.



MANNER OF APPLYING GASOLINE SOAP SPRAY. SHOWER AND TANK, WATER NOT TURNED ON. CAR WITH CLOTHING READY TO BE CYANIDED.



SPRAY FOR GASOLINE SOAP SOLUTION, TANK AND SHOWER.



CYANIDE GENERATOR ATTACHED TO STEAM CHAMBER FOR USE WITH VACUUM PROCESS. SIMPLE AND AUTOMATIC.

For the bather's clothing, large canvas bags, 26 by 46 inches, and duplicate metal checks are provided, to be used as will be described.

Bathing.—Men to be treated are put into one group and women and children into another. Each man entering the bathroom is given a number which is entered opposite his name. He undresses and puts all his effects into the canvas bag on which is pinned one metal check. The duplicate is fastened about his neck. Each piece of his hand baggage is marked with the same number and all of these articles are placed on the carriage of the steam chamber. These disposed of, he steps to the entrance of the shower tub and while turning slowly is sprayed from head to foot with the gasoline soap solution. The force of the spray causes it to penetrate the hairy parts and body creases, but extremely hairy persons and those with matted heads may need extra treatment. The spray may be used on the face, for even if its full force is received in the open eyes they will not suffer any injury nor more discomfort than from strong soap. A drain in the floor takes care of the excess soap solution.

The man now steps over the end of the tank—2 feet—and walks through to the other end, a distance of 15 feet. Ten feet of this is under the shower. He can go slowly and enjoy the shower or get down into the water, but he can not walk very fast as the water is knee-deep. Once well soaped, he is sure to be well washed before arriving at the "clean" end, where he is given two towels and a blanket and awaits his clothes.

Treatment of clothing and baggage.—Of the various methods considered for the treatment of lousy clothing and baggage, cyanide has many advantages. The first arrangement for its application was an air-tight room about 8 by 8 feet, built at the end of the bathhouse. Into this, hydrecyanic acid gas was injected from a small generator situated in the open air. After exposure the gas was entirely removed by an electric fan and two ports opening outside, all operated from without. It was seen, however, that hydrocyanic acid gas could not be relied upon to penetrate either baggage or canvas bags if tightly packed. It was then decided to adopt the method of the United States Department of Agriculture for cyaniding cotton bales to kill the pink bollworm. This method consists of creating a vacuum in a metal chamber holding the bales, liberating cyanide gas in the chamber and then allowing air to enter, which forces the gas into the cotton. The instructions given by the Federal Horticultural Board are briefly as follows:[1]

> A vacuum of 25 inches of mercury is first generated; then cyanide from 6 ounces of sodium cyanide per 100 cubic feet is introduced slowly. The vacuum is then reduced to 5 inches and this held for 1 hour and 25 minutes. The entire process requires 1 hour and 45 minutes, including the time consumed in introducing the gas.

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[1] Federal Horticultural Board. Fed. Hort. Bd. 21. Dec. 4, 1915. Also Federal Horticultural Board circular dated Mar. 16, 1916.

As it is easier to force gas into the center of a tightly packed and closed trunk than into a bale of cotton, and still easier to so treat the ordinary baggage of immigrants, a number of experiments were made to determine what amounts of vacuum, hydrocyanic gas, and time were necessary for this purpose. As the time element is of particular value in quarantine work, it was especially desirable to reduce this as much as possible. In these experiments potato bugs were used instead of lice, as they were available, easily handled, and were shown to be approximately as resistant to cyanide as body lice.

Their resistance may be shown by comparison with the experiments with body lice made by Creel and Faget,[1] as follows:

Number of experiment.	Number of lice.	Container.	Cheesecloth protection to container.	Strength of gas.	Duration of exposure.	Primary inspection.	Final inspection, 24 hours.
					Hrs.		
13	6	Glass jar, 6 oz. capacity.	1 layer	7.5 oz. NaCN per 1,000 cu. ft.	1	All insects stupefied.	All insects dead.
14	6	.....do......	6 layers	.....do......	1	.....do......	4 insects dead, 2 alive.
15	6	.....do......	1 layer, container packed with gauze.	.....do......	1	.....do......	1 insect alive, 5 dead.
16	6	.....do......	1 layer	.....do......	1	.....do......	4 insects dead, 2 alive.
17	6	.....do......	6 layers	.....do......	1	.....do......	Do.
18	6	.....do......	1 layer, container packed with gauze.	.....do......	1	.....do......	2 insects dead, 4 alive.

POTATO BUGS SUBSTITUTED FOR LICE.

Number of experiment.	Number of lice.	Container.	Cheesecloth protection to container.	Strength of gas.	Duration of exposure.	Primary inspection.	Final inspection, 24 hours.
13a	6	Glass jar, 5 oz. capacity: mouth 1¼ inches.	1 layer	7.5 oz. NaCN per 1,000 cu. ft.	1	All insects stupefied.	All insects dead.
14a	6	.....do......	6 layers	.....do......	1	.....do......	2 insects alive, 4 dead.
15a	6	.....do......	1 layer, container packed with gauze.	.....do......	1	.....do......	5 insects alive, 1 dead.
16a	6	.....do......	1 layer	.....do......	1	.....do......	All insects dead.
17a	6	.....do......	6 layers	.....do......	1	.....do......	1 insect alive, 5 dead.
18a	6	.....do......	1 layer, container packed with gauze.	.....do......	1	.....do......	All alive.

Under similar conditions, number of lice killed 25, alive 11: number of potato bugs killed 22, alive 14.

In the experiments made with the vacuum-cyanide process potato bugs were put into ordinary test tubes closed with cotton plugs. These were rolled in old clothes, blankets, or sheepskin coats, in every case making a roll as tight as possible. These packages were put into canvas bags which were tied or the rolls or bags were put into a trunk with tight-fitting lid which was closed and strapped. In every case the protection given the insects was greater than would be expected in the various types of baggage imitated.

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[1] United States Public Health Reports, June 9, 1916.

The following experiments may be cited:

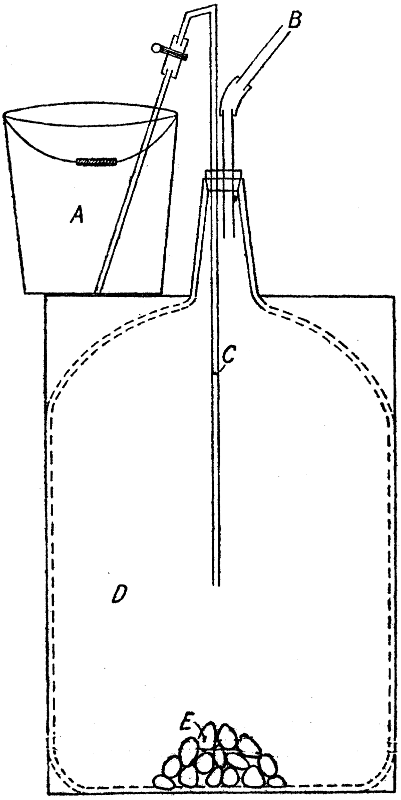
No.	No. of bugs.	Container.	Protection to container.	Vacuum.	Strength of gas.	Exposure.	Primary inspection.	Inspection after 24 hours.
				In.		*Min.*		
1	2	Plugged test tube.	Wrapped in coat, 10 layers and this in canvas bag.	15	1 ounce NaCN per 100 cubic feet.	30	Dead..	Dead.
2	2	.....do...........	2 pairs overalls and coat, 11 layers, in bag.	15	.....do...........	30	Dead..	Dead.
3	2	.....do...........	2 pairs overalls, coat, and blanket, 26 layers, in canvas bag.	15	.....do...........	30	Alive..	Alive.
4	2	.....do...........	.....do...................	15	2 ounces NaCN per 100 cubic feet.	30	Dead..	Dead.
5	2	.....do...........	Wrapped in white coat, 8 layers, and in trunk.	15	.....do...........	30	Dead..	Dead.
6	2	.....do...........	2 pairs overalls and white coat, 10 layers, in trunk.	15	.....do...........	30	Dead..	Dead.
7	2	.....do...........	Same, with 10 layers of blanket and bag in trunk.	15	.....do...........	30	Alive..	Alive.
8	2	Test tube 2 cotton plugs.	Wrapped in sheepskin coat, 2 layers, in bag in trunk.	17	3 ounces NaCN per 100 cubic feet.	30	Alive..	Alive.
9	2	Plugged test tube.	16 layers cloth and 10 of blanket in trunk.	17	.....do...........	30	1 alive, 1 dead.	1 alive, 1 dead.
10	2	As in No. 8......	As in No. 8..............	20	4 ounces NaCN per 100 cubic feet.	30	Alive .	Alive.
11	2	Plugged test tube.	Overalls and cloth, 15 layers, in trunk.	20	.....do...........	30	Dead..	Dead.
12	......	.....do...........	16 layers cloth and 10 of blanket in trunk.	20	.....do...........	30	Dead..	Dead.

From these and other tests it is believed that lice in ordinary hand baggage will be killed by this vacuum-cyanide method with 15 inches vacuum and 30 minutes exposure to hydrocyanic acid gas from 3 ounces of NaCN per 100 cubic feet and in tightly closed trunks by increasing the vacuum to 20 inches and the NaCN to 4 ounces. The conditions created in the experiments were unusually severe. Where the test tube was half filled with a tight cotton plug (experiments 8 and 10) and other unnatural protection given, negative results were not unexpected. In using this method at the Boston quarantine station 15 to 17 inches vacuum with 4 ounces sodium cyanide and 30 minutes exposure will be used, and if trunks are to be treated the lids will be opened.

This is because our apparatus is crude and the vacuum must be produced by the air pump on the quarantine steamer lying 150 feet away and connected by a pipe. When, as planned, the steam chamber is equipped with an electric or gasoline air pump which will produce a vacuum of 20 to 25 inches, it will not be necessary to open even the largest trunks and a reduction of exposure to 20 minutes is contemplated, but at present to create a vacuum of over 15 inches requires too much time.

Several types of cyanide generators, all made at the station, have been tried. The one now in use is very simple and can be made with practically no expense and attached to any steam chamber.

It consists of a 10-gallon carboy fitted with a rubber stopper through which pass two glass tubes, one extending about half way to the bottom of the carboy. The shorter and larger tube is connected to the steam chamber by a short rubber pipe. The longer and smaller tube has a short length of rubber tubing with pinch cock and then a second piece of glass tubing which goes to the bottom of a bucket containing the acid solution.



Cyanide generator, Boston quarantine station, Gallops Island, Boston, Mass. *A*. Fiber bucket containing acid solution. *B*. Gas conducted into the chamber by the creation of a vacuum in chamber. *C*. Glass tube extending halfway to bottom of carboy through which acid solution is drawn. *D*. Ten-gallon carboy in wooden box. *E*. Cyanide of soda in form of eggs dropped in carboy before placing the cork.

The eggs of sodium cyanide are dropped into the carboy, the cork is inserted, and the pinch cock closed on the rubber connection of the acid tube. When the proper vacuum is established in the steam chamber and the carboy, the pinch cock is opened and the negative pressure draws the acid solution into the carboy and into contact with the sodium cyanide. The rate of generation of the gas is thus regulated automatically by the pressure in the carboy, and the operation is complete in less than two minutes. Air enters the acid tube when all the solution has passed over, and after this has continued for two minutes more the valves of the chamber are opened and atmospheric pressure is restored, which requires another five minutes. Time is reckoned from the first injection of cyanide gas, and when this period has elapsed the air pump is run a few minutes to draw out the cyanide and avoid disagreeable effects when the door is opened.

Once the chamber is opened the carriage is pushed to the clean side of the bathhouse and all baggage and clothes are returned to the owners, free from vermin but otherwise in the exact condition in which they were surrendered by them.

For the vacuum an electric or gasoline-driven air pump will not only work rapidly but will make the process entirely independent of steam. It is believed that a further improvement is possible by using a reversible pump that will establish a vacuum, and after the gas has been admitted will pump in air, creating a pressure that will force the fumigant further into the clothing.

Hydrocyanic acid gas has but slight power to kill bacteria and should not be used if this is desired. If the destruction of vermin alone is required, the above method presents the great advantage of not requiring baggage to be opened or even unlocked. As every piece must be unpacked and the contents sorted if steam or dry heat is used and besides this must be dried if immersed in insecticide solution, the advantage in handling large quantities of baggage is striking. As the process is entirely safe, its application need not be limited to typhus suspects, but may be used in lodging houses and similar institutions where it is necessary, on account of vermin, to regularly disinfect the bedding and the clothing of the inmates.

PLAGUE-PREVENTION WORK.

CALIFORNIA.

The following report of plague-prevention work in California for the week ended September 23, 1916, was received from Passed Asst. Surg. Williams, of the United States Public Health Service, in temporary charge of the work:

FEDERAL AND COUNTY INSPECTION SERVICE.

[For the enforcement of the law of June 7, 1913.]

Counties.	Number inspected.	Number reinspected.	Acres inspected.	Acres reinspected.	Acres treated.		Holes treated.
					Waste balls.	Grain.	
Alameda	....	108	....	28,978	17	2,588	3,500
Contra Costa	1	78	600	26,707	....	6,403	....
Stanislaus	38	83	21,529	30,752	....	14,250	....
Santa Cruz	....	36	....	6,339	....	3,753	....
Merced	32	22	14,270	10,890	....	10,280	....
Monterey	18	16	11,540	12,865	....	16,955	....
San Benito	30	54	37,075	22,638	....	34,764	....
Santa Clara	41	12	13,930	2,353	....	1,280	....
San Mateo	9	....	376	....	....	....	....
Total	169	409	99,320	141,522	17	90,273	3,500

RATS COLLECTED AND EXAMINED FOR PLAGUE.

Cities.	Collected.	Examined.	Infected.
Oakland	31	31	None.
Richmond	32	32	Do.
Antioch	81	81	Do.
Total	144	144	None.